# Central Nervous System

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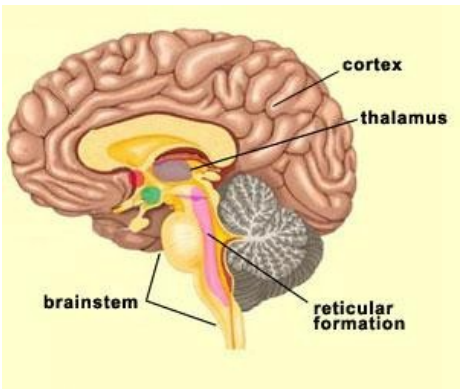
## Reticular formation

- The **reticular formation is** a network of neurons that occupies the midventral portion of the medulla and midbrain. It is primarily an anatomic area made up of various neural clusters and fibers with discrete functions. It contains both sensory and motor neurons.

### 1- Sensory neurons:

- These neurons make interconnections with each others, and allow convergence, divergence and after discharge. These neurons receive afferent impulses from:

a) All ascending lemnisci.
b) Visual, auditory and olfactory nervous p
c) Basal ganglia and cerebellum.
d) Vestibular apparatus.
e) Hypothalamus.
f) Cerebral cortex.




***The reticular***

### 2- Motor neurons:

- It contains facilitatory and inhibitory parts.

**1- Facilitatory reticular formation:**

- It is present in the pons and midbrain.
- It has an intrinsic activity.
- Their long axons are divided into ascending and descending branches.

✓ ***Ascending branch*** discharges excitatory impulses to all areas of cerebral cortex through ascending reticular activating system which is responsible for arousal.

✓ ***Descending branch*** discharges continuously to the spinal motor neurons through ventral reticulospinal tract (exerting a facilitatory effect on spinal gamma motor neurons).

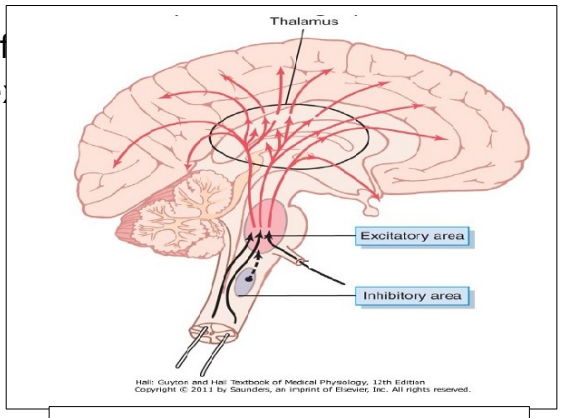
✓

| **The activity of FRF is increased by** | **The activity of FRF is inhibited by** |
|---|---|
| - Area 4. | - Area 6. |
| - Neocerebellum. | - Paleocerebellum. |
| - Vestibular nucleus. | - Red nucleus. |
| - Basal ganglia *(caudate)* | - Basal ganglia |

| | |
|---|---|
| | *(putamen)* |

**2- Inhibitory reticular formation:**

- It is present in the medulla oblongata.
- It has no intrinsic activity.
- It sends inhibitory impulses to the motor neurons of spinal cord through lateral reticulospinal tract.
- Its activity is stimulated by impulses f
  - Inhibitory areas of cerebral corte
  - Paleocerebellum.
  - Basal ganglia.
  - Red nucleus.




***Facilitatory & Inhibitory***

## ▪ Functions of reticular formation:

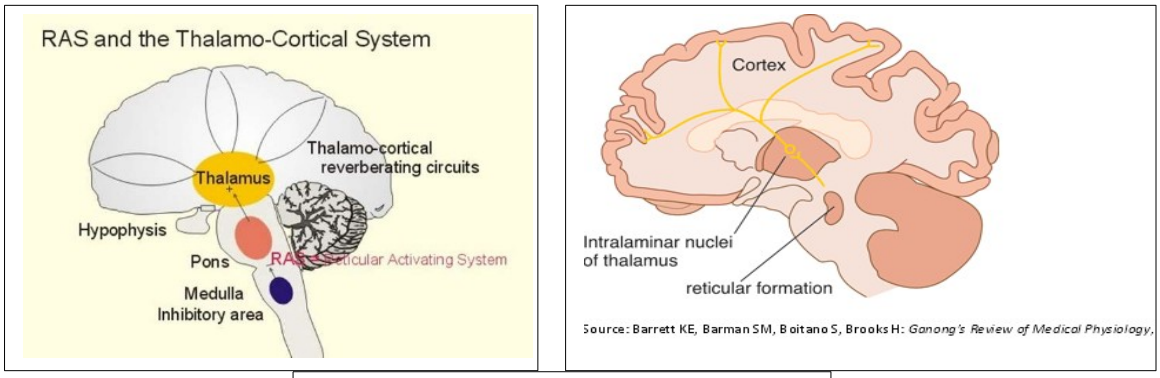
1. It is a **link** between higher centers in the brain and lower centers in the spinal cord, through it these centers are integrated with each other.
2. It contains many areas (**vital centers e.g cardiac, vasomotor & respiratory centers**) concerned with regulation of heart rate, respiration, blood pressure and most of the autonomic functions.
3. It involved in regulation of **stretch reflex** and **muscle tone**.
   Example: During standing there are continuous facilitatory impulses passing from the reticular formation and vestibular nucleus to motor neurons of the spinal cord to increase muscle tone in extensors thus help to support the body.
4. Control the level of consciousness & alertness and regulation of sleep wake cycle through the **ascending reticular activating system** (ARAS), which controls overall activities of the cerebral cortex.
   Example: - Increased activity of RAS causes the normal alert conscious state.
   - Decreased activity of the RAS leads to decreased activity of cerebral cortex,

leading to sleep or loss of consciousness.

5. RAS is concerned with electrical activity of the brain (**EEG**).
6. Reticular formation is the site of perception of **slow pain**. It is also involved in modulation of nociceptive sensations to the cerebral cortex as the periaqueductal grey area (**PAG**) in the midbrain and upper pons and the **raphe nucleus** in the lower pons and upper medulla are part of pain control analgesia system and their serotonergic neurons synapse with pain inhibitory complex (PIC) in spinal cord to block pain transmission.

## The ascending reticular activating system (ARAS or RAS)

- It is a complex multineuronal polysynaptic pathway of nerve fibers that originate at the facilitatory reticular formation. The majority of fibers extends upwards to the non specific thalamic nuclei (intralaminar and reticular nuclei of thalamus), from which other fibers arises and project diffusely to almost all parts of cerebral cortex. This pathway is called ***reticulo-thalamo-cortical pathway***.




***The ascending reticular***

- **Function of ARAS:**
  - The ARAS controls the electrical activity the cerebral cortex and is concerned with consciousness and production of alert response, so reduction in its activity leads to sleep.
    - ✓ It discharges to the thalamus & cortex to potentiate thalamic and cortical activity.
    - ✓ It helps transitions from relaxed wakefulness to periods of high attention & alertness.

- The initiation and maintenance or consciousness is the main function of the ascending reticular activating system (= ARAS). Activation of this system leads to consciousness (through excitation of the cerebral cortex by signals discharged via the *reticulo-thalamo-cortical* pathway).
- Consciousness is then maintained by a *+ve feedback mechanism* through re-excitation of the RAS by signals discharged from the activated cortex via the *corticofugal fibres* (which constitute a *cortico-thalamo-reticular pathway).*

## ▪ Factors that affect the activity of ARAS:

***(A) Factors that increase the ARAS activity:***

1- Sensory signals (especially pain).
2- Signals from the cerebral cortex which increases alertness and resist desire to sleep (e.g. during emotion and voluntary movement)
3- Certain *drugs; called analeptics e.g.* catecholamines, amphetamine and caffeine.

***(B) Factors that decrease the ARAS activity:***

1- Reduction of signals from the sensory pathways or the cerebral cortex.
2- Stimulation of the sleep centers.
3- General anesthetic drugs: These drugs lead to unconsciousness through depressing *the ARAS activity by* inhibiting the synaptic transmission between its neurons.

# Electroencephalogram

- The background electrical activity of the brain in unanaesthetized animals was first described in the 19th century. Subsequently, it was analyzed by the German psychiatrist **Hans Berger**, who introduced the term **electroencephalogram (EEG)** to denote the record of the variations in brain potential. The EEG is recorded with scalp electrodes. EEG recording should be performed in calm room with comfortable temperature and the person should be in complete physical and mental rest.

- The term **electrocorticogram (ECoG)** is used if the electrodes are applied directly on surface of the cortex.

## ▪ EEG:

- It is the record of spontaneous electrical activity of the brain in unanaesthetized subjects by applying electrodes to the scalp of the patient.

## ▪ Clinical uses of the EEG:

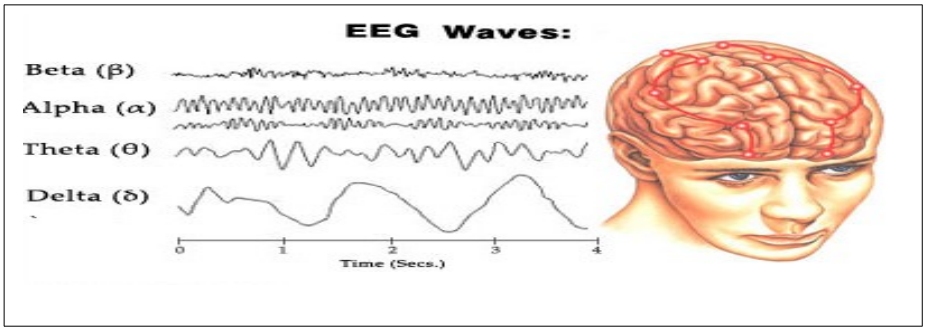
- It is non invasive clinical test for investigating the function of brain.
- The EEG is sometimes of value in localizing pathologic processes.

1. Diagnosis and localization of conditions such as ***subdural hematomas*** (when a collection of fluid overlies a portion of the cortex, the activity over this area may be damped).

2. Lesions in the cerebral cortex (e.g ***brain tumors***) cause local formation of irregular or slow waves that can be picked up in the EEG leads.

3. Diagnosis of ***epilepsy*** (epileptogenic foci sometimes generate high-voltage waves that can be localized).

4. Monitor of sleep stages and diagnosis of sleep disorders.




***Different EEG***

- **Electroencephalogram waves:** four main types of waves are usually recorded

**1. α (Alpha) wave:**
- It is the wave recorded in adult awake relaxed person with closed eyes.
- Site of recording: occipital and parietal region.
- Amplitude: **50 µv**.
- Frequency: **8-13** cycles/sec.

**2. β (Beta) wave :**
- It is the wave recorded in awake person with eyes opened (adult during brain activity) and infants.
- Site of recording: frontal region.
- Amplitude: **25 µv**
- Frequency: **18-30** cycles / sec.

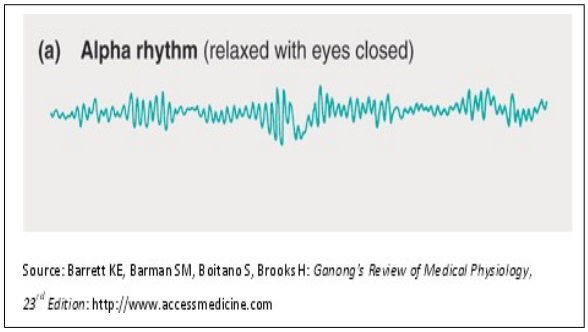
**3. θ (Theta) wave:**
- It is the wave recorded in children and adults during light sleep and emotional stress.
- Site of recording: temporal and partial region.

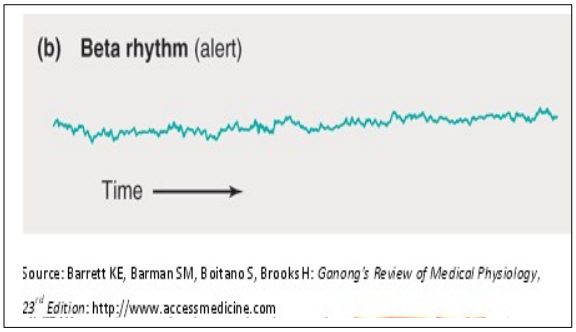
- Amplitude: **100 µv.**
- Frequency: **4-7** cycles/sec.

**4. δ (Delta) wave:**

- It is wave recorded during deep sleep, also recorded in infants and in cases of brain damage.
- Site: all cortical areas.
- Amplitude: **100 µv**.
- Frequency: **0.5-4** cycles/sec.

- **Alpha, Beta Rhythms and alpha block:**




- In adult humans who are awake but at rest and the eyes closed, the most prominent component of the EEG is a regular pattern of waves at a frequency of 8–13 Hz and amplitude of 50 µv. This pattern is the ***alpha rhythm***. It is most marked in the parietal and occipital lobes and is associated with decreased levels of attention.

- When attention is focused on something, the alpha rhythm is replaced by an irregular 18–30 H , low-voltage activity, the ***beta rhythm*** . This phenomenon is called ***alpha block*** and can be produced by any form of sensory stimulation or mental concentration, such as solving arithmetic problems. Another term for this phenomenon is the ***arousal*** *or* ***alerting response,*** because it is correlated with the aroused, alert state.